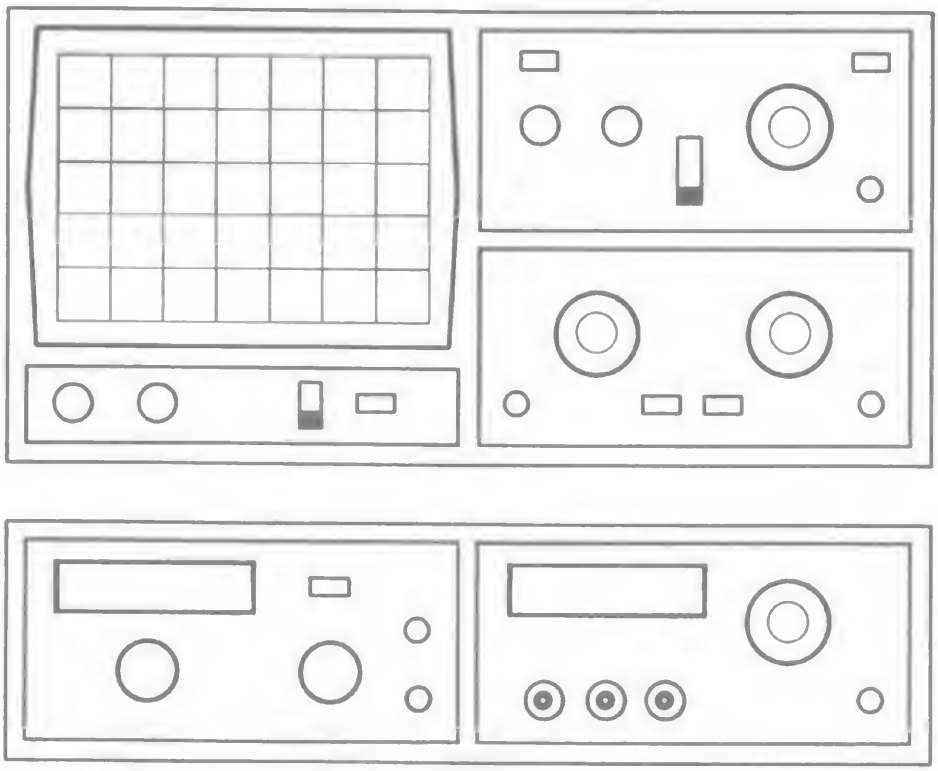
HAMEG
Instruments

MANUAL

Function Generator
HM8030-2



Specification

(Reference Temperature: 23°C ± 1°C)

Operating Modes

Sine-Square-Triangle-DC
free running or ext. frequency modulated, with or without DC offset

Frequency Ranges

0.1 Hz to 1 MHz in 7 decade steps
variable control: x0.09 to x1.1 (12:1)
Frequency Stability: 0.1%/h or 0.3%/24 h at constant ambient temperature (medium position of frequency control)

Waveform Characteristics

Sine Wave Distortion:
0.1 Hz to 100 kHz: max. 0.5%
0.1 MHz to 0.5 MHz: max. 1.5%
0.5 MHz to 1 MHz: max. 3%
Square Wave Risetime: max. 70 ns (10 to 90%)
Overshoot: <5%
(when output is terminated with 50 Ω)
Triangle Non-Linearity: <1% (up to 100 kHz)

Display

Frequency: 4 digit 7 Segm. LED, 8x5 mm each
Accuracy up to 100 kHz: 1% ± LSD[1)]
up to 1 MHz: 3% ± LSD
automatically-positioned decimal point
LED-indicator for Hz and kHz
Overdrive: indicated with two LEDs

Outputs (short circuit proof)

Signal output:
Impedance: 50 Ω
Output voltage: max. 12.5 V_{pp} into 50 Ω
25 V_{pp} open circuit
Attenuation: approx − 60 dB
2 steps: − 20 dB ± 0.2 dB each
Variable attenuation: 0 to − 20 dB
Amplitude Flatness: (sine/triangle)
0.1 Hz up to 0.1 MHz: max. 0.2 dB
0.1 MHz up to 1 MHz: max. 0.5 dB
DC Offset: continuously variable (disconnectible)
Offset range: max. ± 5V into 50 Ω
max. ± 10V open circuit
Trigger Output: square wave synchronous to signal output; approx. 5V (TTL), Fan out: 5

FM Input (VCF)

Frequency change: max. 1:100
Input impedance: 100 kΩ ‖ 25 pF
Input voltage: ± 30 V max.

General Information

Operating conditions: + 10°C to + 40°C
max. relative humidity: 80%
Supply (from HM 8001): + 5V/0.1 A
+ 20V/0.27 A; − 20V/0.25 A
(Σ = 10.9 W)
Dimensions (mm): (without multipoint conn.)
W 135, **H** 68, **D** 228 mm
Weight: approx. 0.80 kg

[1)] Least Significant Digit

Subject to change without notice

Function Generator HM 8030-2

- **Frequency Range 0.1 Hz to 1 MHz**
- **Operating Modes: Sine, Square, Triangle, DC**
- **Digital Frequency Readout**
- **DC-Offset Adjustment**
- **FM-Input; Trigger Output**

The **various signals** available from the **HM 8030-2** function generator module make it a versatile signal source useful for most measurement and test applications. Its **low frequency ranges** are particularly well suited for simulating mechanical and servo techniques.
Frequencies are read out on a **4 digit LED display**. A variable frequency control with a gear ratio of 4.6:1 facilitates accurate frequency adjustments. Additional quality features include the relatively **low distortion factor** of the generated signals and **constant amplitude flatness** throughout the entire frequency range of the instrument.
When the **HM 8030-2** is operated in the **offset mode**, output level clipping is indicated by LEDs. All outputs are **short-circuit-proof**. With an external signal source, the **HM 8030-2** can also be used in the **sweep mode**.

Optional Accessories

HZ 33, HZ 34: 50 Ω test cable BNC-BNC.
HZ 22: 50 Ω through-termination.

Printed in West Germany

General information

This plug-in module is primarily intented for use in conjunction with the Mainframe HM8001. When incorporating it into other systems, the module should only be operated with the specified supply voltages.

The logical front-panel layout of the module ensures rapid familiarisation with the various functions. However, even experienced operators should not neglect to carefully read the following instructions and those of the mainframe HM8001, to avoid any operating errors and to be fully acquainted with the module when later in use.

After unpacking the module, check for any mechanical damage or loose parts inside. Should there be any transportation damage, inform the supplier immediately and do not put the module into operation.

Safety

Every module is manufactured and tested for use only with the mainframe HM8001 according to IEC 348 Part 1 and 1a (Safety requirements for electronic test and measurement equipment). All case and chassis parts are connected to the safety earth conductor. Corresponding to Safety Class 1 regulations (three-conductor AC power cable). Without an isolating transformer, the instrument's power cable must be plugged into an approved three-contact electrical outlet, which meets International Electrotechnical Commission (IEC) safety standards:

Warning!

Any interruption of the protective conductor inside or outside the instrument or disconnection of the protective earth terminal is likely to make the instrument dangerous. Intentional interruption is prohibited.

When removing or replacing the metal case, the instrument must be completely disconnected from the mains supply. If any measurement or calibration procedures are unavoidable on the opened-up instrument, these must only be carried out by qualified personnel acquainted with the danger involved.

Operating conditions

The ambient temperature range during operation should be between +10°C and +40°C and should not exceed −40°C or +70°C during transport or storage. The operational position is optional, however, the ventilation holes on the HM8001 and on the plug-in modules must not be obstructed.
Prior to calibration a preheat run of approx. 30 minutes is required.

Warranty

Before being shipped, each plug-in module must pass a 10 hour quality control test. Most failures can be detected by means of intermittent operation during this test. Nevertheless, a component may fail, but only after a longer period of operation.

all HAMEG instruments are under warranty for a period of two years, provided instrument has not undergone any modifications. HAMEG will repair or replace products, which prove to be defective during the warranty period. No other warranty is expressed or implied. HAMEG is not liable for consequential damages. The instrument should be returned in its original packaging for maximum protection. We regret that transportation damage due to poor packaging is not covered by this warranty.
In case of any complaint, attach a tag to the instrument with a description of the fault observed. Please supply name and department, address and telephone number to ensure rapid service.

Maintenance

The most important characteristics of the module should be periodically checked. The instructions provided in the operation tests in this manual can easily be carried out without using expensive test equipment.
If necessary, remove dust from inside the module using a small brush. Grease stains can be removed with suitable spirit. The multi-point connector at the back of the module should also be cleaned. ***Attention! In case of cleaning the module the red display pane should not come in contact with alcohol or methylated spirit.*** If maintenance is problematic please contact your nearest HAMEG distributor.

Removal of Case

Detach mains/line cord and any other connected cables from case of the mainframe HM8001. Remove both screws on rear panel and, holding case firmly in place, pull chassis forward out of case.

When later replacing the case, care should be taken to ensure that it properly fits under the edges of the front and rear panels.

After removal of the two screws at the rear of the module, both chassis covers can be lifted. When reclosing the module, care should be taken that the guides engage correctly with the front chassis.

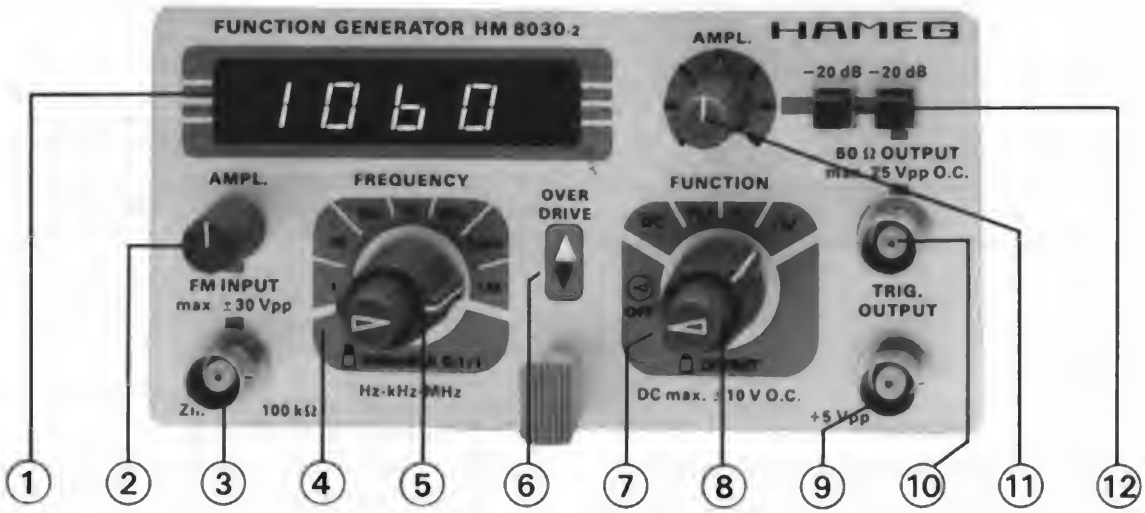
First-time operation of the module

Provided that all hints given in the operating instructions of the HM8001 Mainframe were followed – especially for the selection of the correct mains voltage – start of operation consists practically of inserting the module into the right or left opening of the mainframe. The following precautions should be observed:

Before exchanging the module, the mainframe must be switched off. A small circle (o) is now revealed on the red power button in the front centre of the mainframe.

If the BNC socket at the rear panel of the HM8001 unit was in use before, the BNC cable should be disconnected from the basic unit for safety reasons. Pull out the previously used module by its handle and slide in the new module until the end position is reached.
The mains plug of the HM8001 should be inserted before connections are made to measuring circuits.

Control elements of HM8030-2



① **DISPLAY** (7-segment LED)
4-digit frequency meter; LED indicators for Hz and kHz.

② **AMPLITUDE** (adjusting knob)
Attenuation of input voltage for FM-input. This permits the user to change the sweep width.

③ **FM INPUT** (BNC connector)
Applying a DC voltage to this input will vary the oscillator frequency linearly to max. 1:100. The max. allowable input voltage is ±30V.

④ **VARIABLE** (adjusting knob)
Continuous and linear frequency adjustment, overlapping the ranges selected with ⑤. Setting range from x0.09 to x1.1 of selected range. Gear ratio is 4.6:1.

⑤ **FREQUENCY** (7-position rotary switch)
Frequency coarse adjustment from 1Hz to 1MHz in 7 decade steps.

⑥ **OVERDRIVE** (LEDs)
When working in the offset mode, and the output amplifier is overdriven either in positive or in negative direction, the corresponding LED lights up.

⑦ **OFFSET** (adjusting knob)
Adjustment of the positive or negative offset voltage. This DC voltage can be superimposed on the output signal. The max. offset voltage is ±10V (o.c.) or ±5V respectively when terminated with 50Ω. This voltage is also available in DC mode. When the knob is in CAL. position (fully ccw position), the offset voltage is switched off.

⑧ **FUNCTION** (4-posititon rotary switch)
Mode selection: Triangle – Sine – Square – DC.

⑨ **TRIGGER OUTPUT** (BNC connector)
This short-circuit-proof output supplies a square signal in synchronism with the output signal. It is TTL compatible and has a duty-factor of approx. 50%.

⑩ **50 Ω OUTPUT** (BNC connector)
Short-circuit-proof signal output of the generator. The output impedance is 50 Ω, and the max. output amplitude is 25Vpp (o.c.) or 12.5Vpp respectively when terminated with 50 Ω.

Attention! Do not apply any DC voltage to the output socket.

⑪ **AMPLITUDE** (adjusting knob)
Continuous adjustment of the output amplitude from 0 to −20dB when terminated with 50 Ω.

⑫ **−20dB, −20dB** (pushbutton)
Two fixed attenuators, −20dB each. They can be used separately. When both buttons are activated, a total of −40dB results. Including the amplitude control ⑪, the max. attenuation amounts to −60dB (factor 1000).

Operation

Function selection

The type of output signal is selected with the function selection switch ⑧. A total number of 3 different waveforms – sine, square and triangle – are available. The individual positions are marked with the corresponding symbols. In the "DC" position, a DC voltage level is supplied by the HM8030-2.

Frequency adjustment

Coarse adjustment is performed with the range switch ⑤ divided into decades. The desired frequency is selected by turning the VARIABLE control ④. The selected frequency appears on the 4-digit display ①. Compared to knob scales, this display has a much higher resolution. To facilitate a precise frequency adjustment of the last digit, a gear ratio of 4.6:1 of the frequency adjustment potentiometer is provided. The Hz and kHz range indicators are integrated into the display panel.

Output amplitude and signal connection

Adaptation in decade steps to the desired amplitude range is performed by the use of two attenuators with −20dB each, which are activated by pushbuttons.

Including the continuously adjustable AMPLITUDE control ⑪, the maximum attenuation amounts to −60dB. With the maximum amplitude of $12.5V_{pp}$, the minimum signal voltage to be supplied is about 12.5mV. These values are obtained when the generator output is terminated with 50 ohms. In the open-circuit condition, the available signal amplitude is about twice as high. Therefore the maximum output voltage of the output socket is specified with $25V_{pp}$. If exact square-shaped signals are required, care should be taken that only 50 ohms coaxial cables (e.g. HZ34) are used. Furthermore, this cable must be terminated with a 50 ohms through-termination (e.g. HZ22). If these precautions are not observed, overshoot may occur, especially when high frequencies are selected. If test circuits having a 50 ohms input impedance are connected, this termination is not required. In high signal voltage ranges, it should be noted that the used terminating resistor must dissipate the corresponding effective power.

Do not apply any DC voltage to the output sockets of the HM8030-2 Module!

If the output of the HM8030-2 unit comes into contact with components of the circuit under test, which are carrying DC voltage (i.e. if the load resistor is superposed with a DC voltage), an isolating capacitor of appropriate dielectric strength should be connected in series with the output line of the generator. The capacitance of this isolating capacitor should be selected in that way that the frequency response of the output signal is not affected over the whole frequency range of the HM8030-2 unit.

Trigger output

In the sine, square and triangle modes, the trigger output ⑨ supplies a square signal in synchronism with the output signal. An offset voltage adjusted at the 50 ohms output has no influence upon the trigger signal. The trigger output is short-circuit-proof and can drive several TTL inputs. If the trigger output is loaded with 50 ohms, the value falls far below the TTL level. Therefore only short or low-capacitance cables without a 50 ohms terminating resistor should be used for connection.

FM input

If a positive DC voltage is applied to the FM input ③, the generator frequency increases and is accordingly displayed. A negative DC voltage reduces the frequency. The frequency displacement depends on the value and polarity of the DC voltage **U** and on the **VARIABLE** setting. The set frequency $\mathbf{N_0}$ (DC voltage not included) can be selected at will.

Computation: $\mathbf{N = N_0 + A \cdot U}$ or $\mathbf{U = (N - N_0) : A}$

$\mathbf{N_0}$ = digit display without voltage **U**,
N = digit display including voltage **U**,
U = ± voltage at the FM input.
A = 0-680 (digits per volt),
("A" depends on Amplitude ② setting.)

It should be noted that only the displayed digits are valid; the decimal point is not taken into consideration (e.g. 100.0 ≙ 1000 digit). The display "1999" cannot and "000" should not be exceeded. Any zeroes preceding the decimal point are dropped.

Limits: if the highest displayed number is **N** = 1998 and the smallest $\mathbf{N_0}$ = 090, then **U** will be +2.8V max. The frequency increases by a factor of 22.2. If the smallest displayed number is **N** = 011 (lower numbers are possible, but inaccurate) and the highest $\mathbf{N_0}$ = 1100, then **U** will be −1.6V max. The frequency changes by a factor of 100.

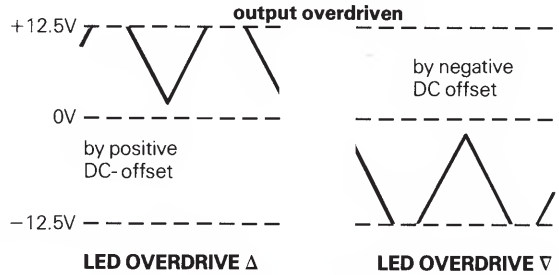
The frequency change is ***linear*** as a function of the voltage **U** and has the same value in all ranges.
The specified values are only obtained if the amplitude control knob ② is turned fully clockwise.

DC offset

If the offset knob ⑦ is not in its calibrated position, a DC voltage can be superimposed on the output signal. The maximum offset voltage with open output is ±10V.

Overdrive LEDs

As soon as the maximum value of the output signal exceeds $\pm 12.5V_p$ (overdriving of the output amplifier), the signal peaks are cut off (voltage clipping). Accordingly, the overdrive indicators are light up in case of positive or negative overdriving.



Operational check

General

This test will permit you to check the functions of the HM8030-2 unit at certain time intervals without using any special test equipment . To obtain the normal operating temperature, the mainframe with inserted module should be turned on at least 30 minutes before starting the test.

Measuring equipment required

20 MHz Oscilloscope: HM 203 or HM 204
HZ 22 50 ohms Through-Termination
HM 8011-2 Digital Multimeter
Adjustable DC voltage source (max. 30 V)
For adjustment only:
HM 8027 Distortion Meter
HM 8021-2 Frequency Counter

Frequency variation of all ranges

Setting		Nominal value	Setting		Nominal value
⑤	④	①	⑤	④	①
1	min	.080 Hz	1 k	max	1200 Hz
1	max	1.200 Hz	10 k	min	0.80 kHz
10	min	0.80 Hz	10 k	max	12.00 kHz
10	max	12.00 Hz	100 k	min	08.0 kHz
100	min	08.0 Hz	100 k	max	120.0 kHz
100	max	120.0 Hz	1 M	min	080 kHz
1 k	min	080 Hz	1 M	max	1200 kHz

The indicated nominal values include unavoidable tolerances. However, the adjustment range of the **VARIABLE** knob ④ must in any case overlap the decade on both sides.

Stability of the output amplitude

Setting:	⑧	⑤	④	⑪
	∿	1 k	max	max

Connect oscilloscope to output ⑩. Use a 50 ohms through-termination. Set oscilloscope to DC coupling. Adjust signal height to 6 div. Check all frequency ranges with ⑤ and ④. The signal height should not vary by more than 0.2 div for all frequencies. This check should also be carried out for the other signal waveforms.

Maximum output amplitude

Setting:	⑧	⑤	④	⑪	⑫
	∿	1 k	max.	max.	no button pressed

Connect oscilloscope to output ⑩. The signal amplitude should be 25 V_{pp} ± 500 mV_{pp}. With a 50 ohms load at the output ⑩, the signal amplitude should still be 12.5 V_{pp} ± 250 mV_{pp}.

Output attenuator function

Setting:	⑧	⑤	④	⑪	⑫
	∿	100	50 Hz	max.	no button pressed

Connect digital multimeter (V_{AC}) to output ⑩. Set knob ⑪ for 10 V display. Firstly press button ⑫ (– 20 dB) only, then both buttons ⑫ (– 40 dB) simultaneously. The DVM should display 1 V or 0.1 V ± 2% respectively.

Adjustment range of the offset voltage

Setting:	⑧	⑤	④	⑪
	∿	10 k	max	max

Operational check with DC voltage or signal using the offset knob.

Connect oscilloscope to the output ⑩ (2 V/div). Use a 50 ohms through-termination. Set to DC coupling. The signal amplitude then extends over about 5 div. If control ⑦ is turned clockwise to the uncalibrated position, the output signal is limited shortly below the upper screen border. If control ⑦ is turned counter-clockwise, the same phenomenon is observed at the lower screen border. The DC potential may be varied between about + 5 V and – 5 V by use of control ⑦.

Frequency variation by FM input

Setting: optional; ⑧ not in DC position. ② fully cw.

Apply an adjustable DC voltage (± 30 V max.) to the input ③. Display indication ① will vary as a function of the applied DC voltage. The obtained results can be examined by use of the formulas specified in the **"FM input"** section of the operating instructions.

Signal waveform at the trigger output

Setting: optional; ⑧ not in DC position.

Connect the oscilloscope to output ⑨. A square wave signal with TTL level and a 50% duty factor will be shown on the screen ("Low": about 0.4 V; "High": about 5 V). When DC position ⑧ is selected, the trigger output ⑨ will supply about + 5 V DC.

Adjustment procedure

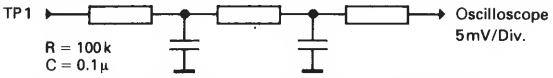
The following instructions will permit you to correct any deviation of the module from the nominal data. The specified adjustment sequence should be strictly observed.
Before opening the set, you should carefully read the **Safety** and **Warranty** information on page M2 of these operating instructions.

Adjustment steps

A – Triangle amplitude symmetry

Setting: ⑧ ∿ ⑤ 1 k ④ 1 k ① 1000 Hz

Connect oscilloscope (DC coupling) to TP 1 using the following circuit: (The TP 1 test point is located next to the amplitude control on the upper PC board).



Adjust [11], until a value of 0 V ± 2 mV is obtained.

B – Triangle amplitude at 1 kHz

Setting: see A.

Connect multimeter to TP 1. V_{AC} measurement range (rms measurement). Adjust [9], until 1.15 V_{rms} are obtained.

C – Triangle amplitude at 1 MHz

Setting: see A

Connect oscilloscope to TP 1. Select a screen height of 6 divisions. Then:

Setting: ⑧ ∿ ⑤ 1 M ④ 1 M ① 1 M

Adjust [10], until a signal height of 6 divisions is obtained.

D – 1 kHz square wave duty cycle

1. Setting: ⑧ ⊓ ⑤ 1 k ④ max. ① ~1200 Hz

Connect oscilloscope to output ⑧. Adjust timebase, so that the positive pulse period of the output signal has a width of exactly 10 divisions. Set the trigger edge control (slope) of the oscilloscope to negative edge triggering. Adjust [4], until the negative pulse length equals the positive pulse length on the screen.

2. Setting: ⑧ ⊓ ⑤ 1 k ④ min. ① ~90 Hz

Repeat the procedure described under 1. Check the result of step 1 and if necessary repeat the adjustment.

E – 100 Hz square wave duty cycle

Setting: see D, but set ⑤ to 100 Hz.

F – Distortion adjustment

Setting: ⑧ ∿ ⑤ 1 k ④ max.

Connect the distortion meter to TP 1. Alternatively adjust [13] and [14], until the minimum value is obtained.

G – Accuracy rating of the frequency ranges

Setting: ⑧ ∿ ⑤ according to the range to be adjusted

Connect frequency counter to output ⑨. Adjust ④ until the connected frequency counter indicates the value of the selected range (1 kHz, 10 kHz etc.). Then adjust [X], until the display ① indicates the same value as the frequency counter.

The frequency ranges are adjusted in the following order:

	1 kHz	100 Hz	10 kHz	1 MHz	100 kHz
[X] corresponds to:	[6]	[7]	[2]	[5]	[1]

H – Square wave signal adjustment

Setting: ⑧ ⊓ ⑤ 1 M ④ max. ⑪ max.

Adjust [16] for minimum overshoot or rounding, respectively, of the rising edge.

(The required trimmer is located on the upper PCB next to the amplitude control.)

Electronic Parts List

Ref. No.	Description			Ref. No.	Description			Ref. No.	Description		
R 101	147 kΩ	1 %	TK 50	R 123	100 Ω	1 %	TK 50	R 144	562 Ω	1 %	TK 50
R 102	6,8 Ω	5 %	TK 100	R 124	51,1 Ω			R 145	6,8 Ω	5 %	TK 100
R 103	205 kΩ	1 %	TK 50	R 125	383 kΩ			R 146	18,2 kΩ	1 %	TK 50
R 104	27,4 kΩ			R 126	38,3 kΩ			R 147	6,49 kΩ		
R 105	27,4 kΩ			R 127	3,83 kΩ			R 148	274 Ω		
R 106	4,64 kΩ			R 128	6,19 kΩ			R 149	681 Ω		
R 107	2,7 MΩ			R 129	442 Ω			R 150	2,74 kΩ		
R 109	42,2 kΩ			R 130	14,7 kΩ			R 151	18,2 kΩ		
R 110	6,8 Ω	5 %	TK 100	R 131	14,7 kΩ			R 152	6,49 kΩ		
R 111	536 Ω	1 %	TK 50	R 132	1,47 kΩ			R 153	681 Ω		
R 112	681 Ω			R 133	100 Ω			R 154	274 Ω		
R 113	2,05 kΩ			R 134	1,47 kΩ			R 155	2,74 kΩ		
R 114	18,2 kΩ			R 135	1 kΩ			R 156	100 Ω		
R 115	1,78 kΩ			R 136	82,5 kΩ			R 157	215 Ω		
R 116	14,7 kΩ			R 137	1 kΩ			R 158	1 kΩ		
R 117	adjustment			R 138	51,1 Ω			R 159	464 Ω		
R 118	82,5 kΩ			R 139	383 Ω			R 160	14,7 Ω		
R 119	825 Ω			R 140	51,1 Ω			R 161	3,01 kΩ		
R 120	1,78 kΩ			R 141	2,15 kΩ			R 162	14,7 Ω		
R 121	909 Ω			R 142	6,8 Ω	5 %	TK 100	R 163	909 Ω		
R 122	100 Ω			R 143	215 Ω	1 %	TK 50	R 164	1 kΩ		

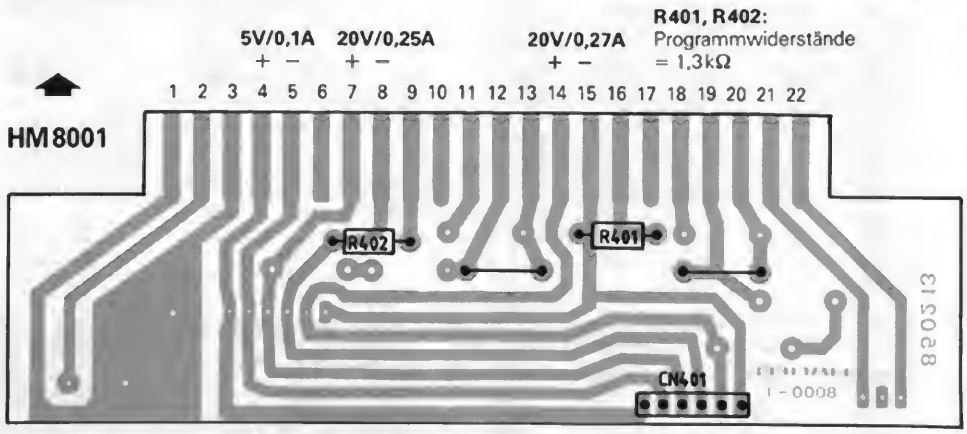
Ref. No.	Description		
R 165	51,1 Ω	1%	TK 50
R 166	6,8 Ω	5%	TK 100
R 167	1,47kΩ	1%	TK 50
R 168	6,8 Ω	5%	TK 100
R 169	1kΩ	1%	TK 50
R 170	1,27kΩ		
R 171	3,65kΩ		
R 172	2,15kΩ		
R 173	2,15kΩ		
R 174	1kΩ		
R 175	6,81kΩ		
R 176	5,11kΩ		
R 177	2,37kΩ		
R 178	15,4kΩ		
R 179	18,2kΩ		
R 180	51,1 Ω		
R 181	1,78kΩ		
R 182	1,62kΩ		
R 183	1,78kΩ		
R 184	1,96kΩ		
R 185	100 Ω		
R 186	2,49kΩ		
R 187	2,49kΩ		
R 188	6,8 Ω	5%	TK 100
R 189	6,8 Ω	5%	TK 100
R 190	750 Ω	1%	TK 50
R 191	4,64kΩ	1%	TK 50
R 192	1kΩ	1%	TK 50
R 193	6,8 Ω	5%	TK 100
R 194	681 Ω	1%	TK 50
R 195	51,1 Ω	1%	TK 50Ω
R 196	51,1 Ω	1%	TK 50Ω
R 197	51,1 Ω	1%	TK 50
R 198	2,2 Ω	5%	TK 100
R 201	100kΩ	1%	TK 50
R 202	215kΩ		
R 203	215kΩ		
R 204-207	1kΩ		
R 208-214	100 Ω		
R 215	10kΩ		
R 216	10kΩ		
R 217	100 Ω		
R 218	100 Ω		
R 219	147 Ω		
R 220	178 Ω		
R 221	6,8 Ω	5%	TK 100
R 222	21,5kΩ	1%	TK 50
R 223	1,62kΩ		
R 224	6,8 Ω	5%	TK 100
R 225	1,27kΩ	1%	TK 50
R 226	1,27kΩ		
R 227	51,1 Ω		
R 228	51,1 Ω		
R 229	3,83kΩ		
R 230	51,1 Ω		
R 231	51.1 Ω		
R 232	100 Ω		
R 233	6,8 Ω	5%	TK 100
R 234	61,9 Ω	1%	TK 50
R 235	6,8 Ω	5%	TK 100
R 236	511 Ω	1%	TK 50
R 237	9,53kΩ	1%	TK 50
R 238	1,96kΩ	1%	TK 50
R 239	1,96kΩ	1%	TK 50
R 240-243	6,8 Ω	5%	TK 100
R 244	215 Ω	1%	TK 50
R 245	464 Ω		
R 246	100kΩ		
R 247	100kΩ		
R 248	464 Ω		

Ref. No.	Description		
R 249	7,5kΩ	1%	TK 50
R 250	33,2kΩ		
R 251	7,5kΩ		
R 252	100 Ω		
R 253	100 Ω		
R 254	10 Ω		
R 255	40,2 Ω		
R 256	40,2 Ω		
R 257	10 Ω		
R 258	40,2 Ω		
R 259	40,2 Ω		
R 301	215 Ω		
C 101	10µF	35V	
C 102	1nF	63V N2000	10%
C 103	10µF	35V	
C 104	10pF	63V NPO	
C 105	470pF	160V	1%
C 106	47nF	100V	10%
C 107	0,47µF	100V	20%
C 108	47nF	160V	1%
C 109	3,9nF	160V	1%
C 110	270pF	160V	2,5%
C 111-114	10µF	35V	
C 115	22nF	63V	20%
C 116	10µF	35V	
C 117	220pF	63V NPO	10%
C 118	22nF	63V	20%
C 119	10µF	35V	
C 120-121	22nF	63V	20%
C 122	68pF	63V NPO	10%
C 123	10µF	35V	
C 124	22nF	63V	20%
C 125	10µF	35V	
C 126-127	33pF	63V NPO	10%
C 128	22nF	63V	20%
C 129	56pF	63V NPO	10%
C 130	27pF	63V NPO	10%
C 131	3,9pF	160V	1%
C 132	22nF	63V	20%
C 133	10µF	35V	
C 135	10µF	35V	
C 136-138	22nF	63V	20%
C 201-204	0,1µF	400V	20%
C 205	470µF	40V	
C 206	0,1µF	400V	20%
C 207	22nF	63V	20%
C 208	10µF	35V	
C 209	22nF	63V	20%
C 210	10µF	35V	
C 211	22nF	63V	20%
C 212	120pF	63V NPO	10%
C 213	2pF	63V NPO	10%
C 214-215	10µF	35V	
C 216	10pF	63V NPO	10%
D 101-135	1N4149		
D 136	FDH300		
D 201-213	1N4149		
IC 101	TL082		
IC 102	TL082		
IC 103	TL81		
IC 104	7812		
IC 105	7912		
IC 106	LF356		
IC 107	CA3086		
IC 108	TL81		
IC 201	MC14433		
IC 202	4511		

Ref. No.	Description	
LED 301	TLSO5101	
LED 302	TLSO5101	
LED 303	KLY207E	
LED 304	KLY207E	
DL 301	HP5082-7613	
DL 302	HP5082-7613	
DL 303	HP5082-7613	
DL 304	HP5082-7613	
T 101	BC557B	
T 102	BC239C	
T 103	BC557B	
T 104	BC239C	
T 105	U441	
T 106	BC237B	
T 107	BC557B	
T 108	BC557B	
T 109	2N2219A	
T 110	BC237	
T 111	BC237	
T 112	BC557	
T 113	BF440	
T 114	BF440	
T 115	BF199	
T 116	BF440	
T 117	BSX19	
T 118	BC237	
T 119	BC557	
T 201	BC237B	
T 202	BC237B	
T 203	BC237B	
T 204	BC237B	
T 205	BC557	
T 206	BSX19	
T 207	BSX19	
T 208	2N2905A	
T 209	2N2905A	
T 210	2N2219A	
T 211	2N2905A	
T 212	BC557	
T 213	BC557	
T 214	BC237	
T 215	BC237	
VR 101	100kΩ	20% lin.
VR 102	5kΩ	
VR 103	100 Ω	
VR 104	25kΩ	
VR 105	10kΩ	
VR 106	100kΩ	
VR 107	25kΩ	
VR 108	25kΩ	
VR 109	250 Ω	
VR 110	2,5kΩ	
VR 111	1kΩ	
VR 112	5kΩ	
P 101	47kΩ	20% lin.
P 102	10kΩ	
P 103	100kΩ	
P 201	2,2kΩ	
VC 101	5-22pF	
VC 102	2-22pF	
VC 103	2-22pF	
Z 201	5V6	

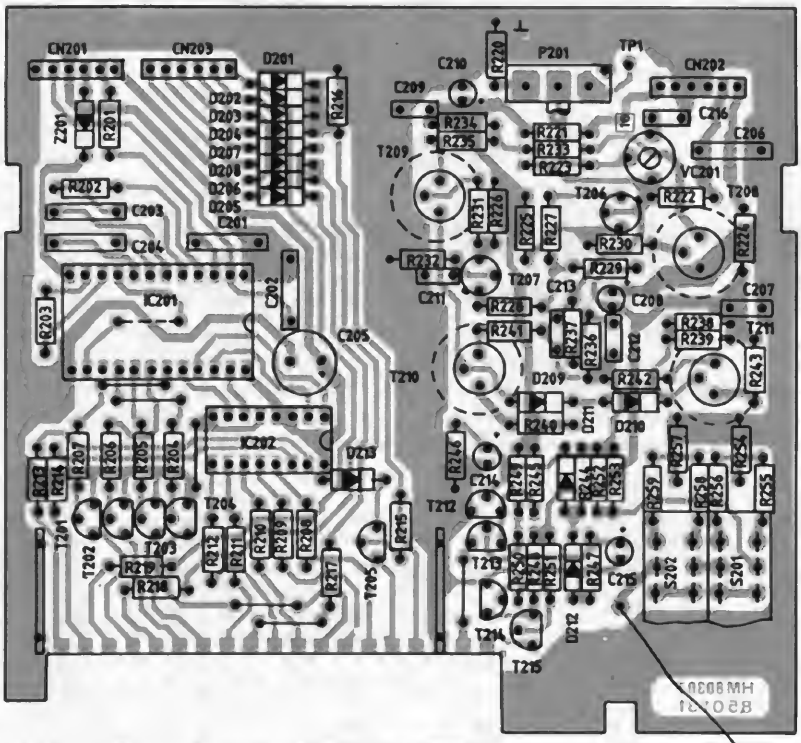
Steckerleiste; Versorgungsspannungen
Carte connecteur

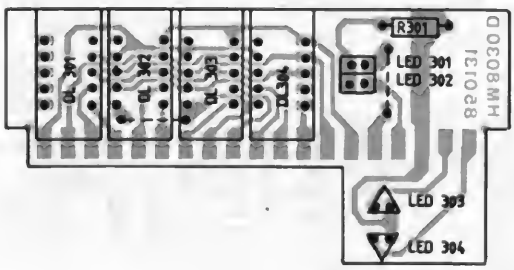
Multipoint Connector; Supply Voltages
Placa conector de alimentacion



Verstärkerplatte
Output board

Carte sortie
Placa salida

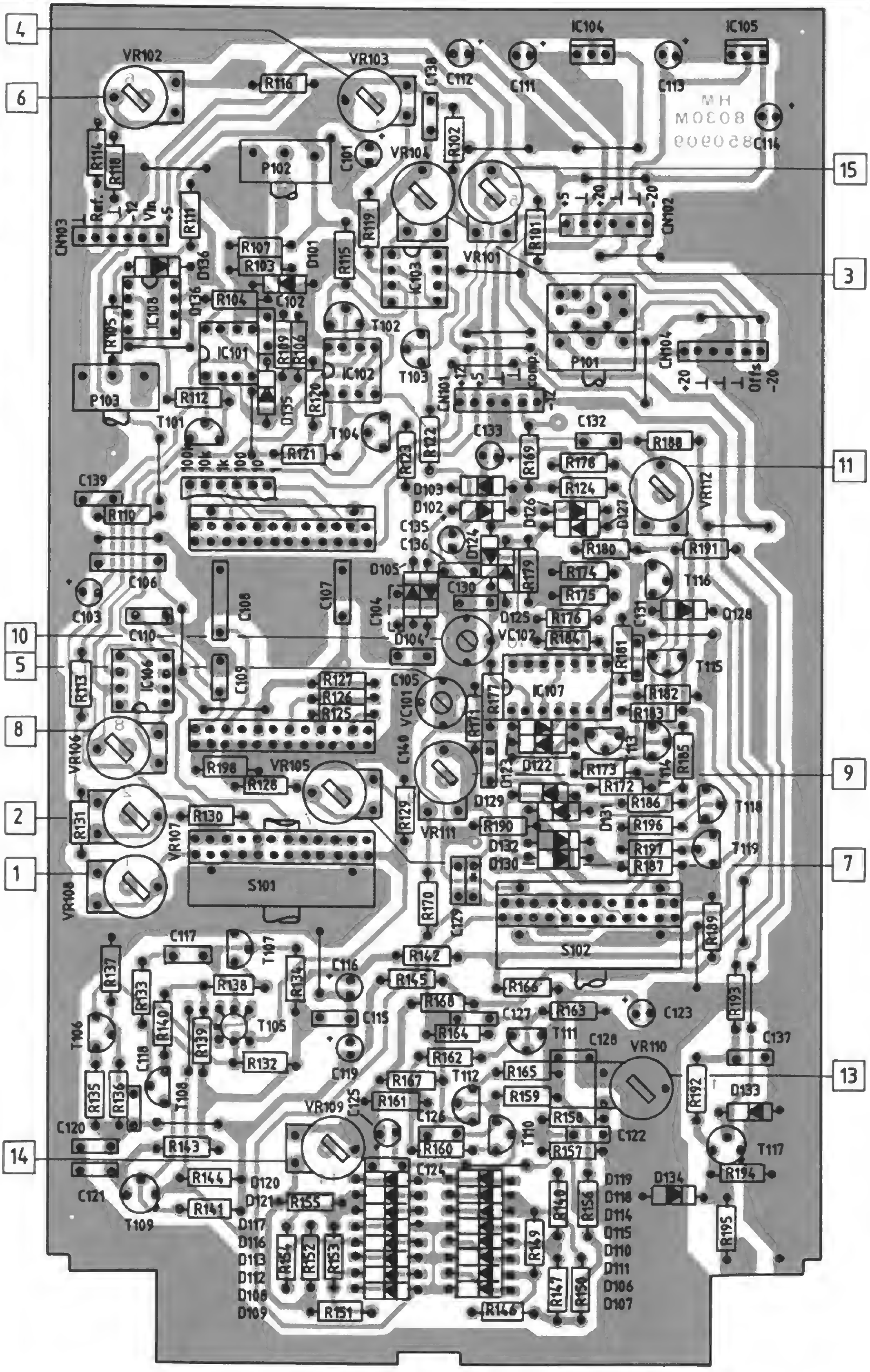




Anzeigeplatte
Carte affichage
Display Board
Placa indicador

Component Locations (Main Board)
Localizacion de componentes; placa base

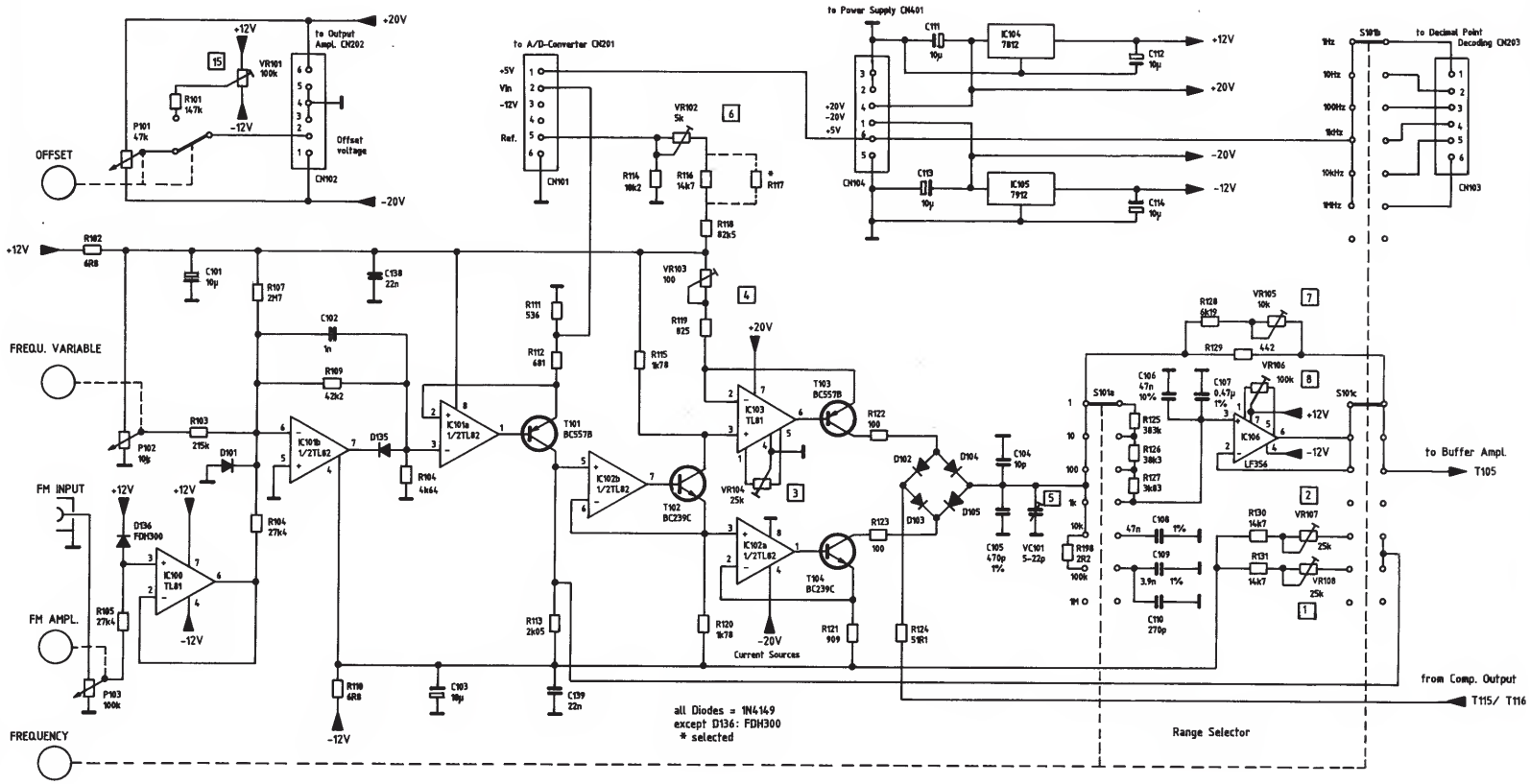
Bestückungsplan
Implantation des composants



* as required

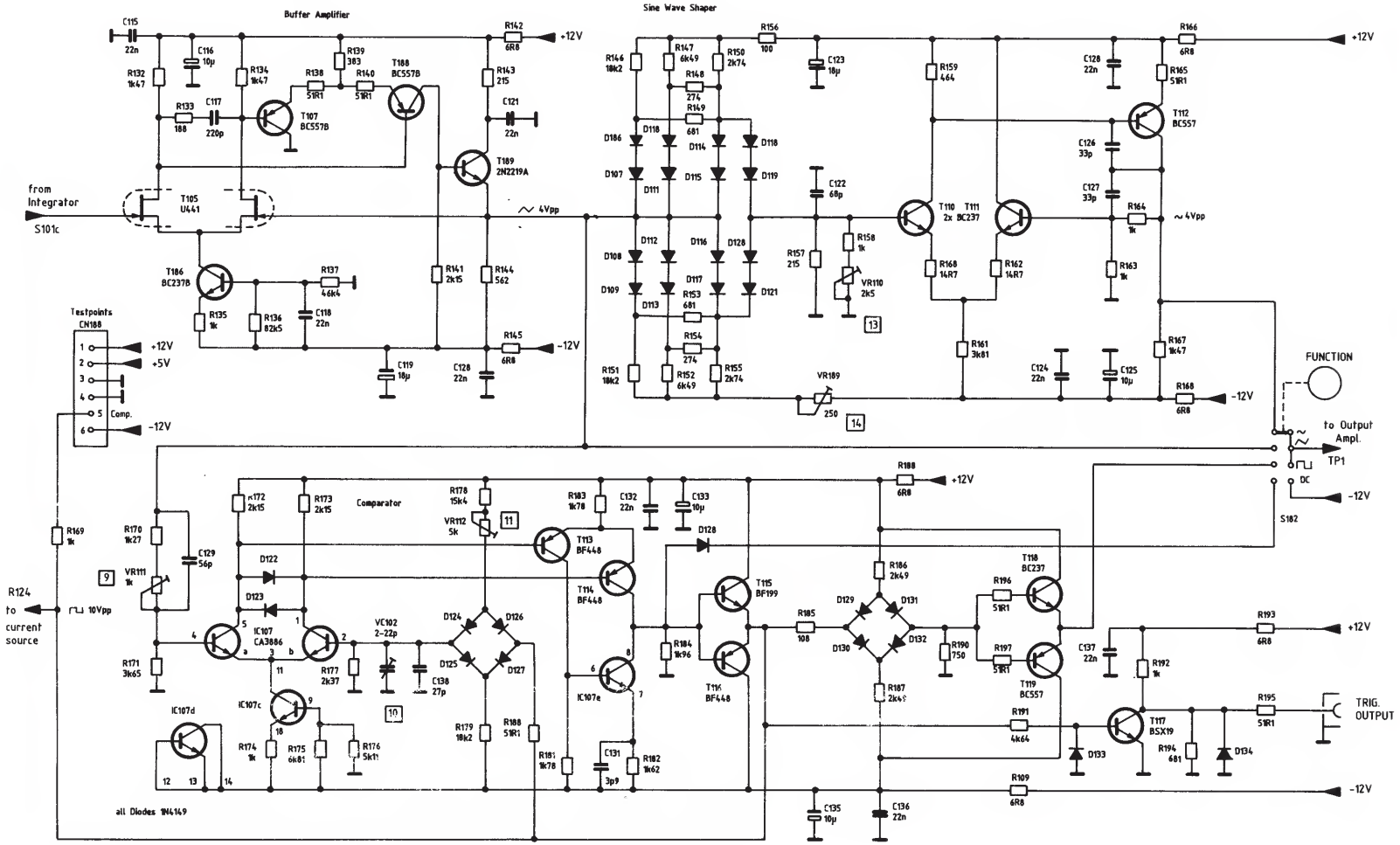
Generator, Frequenzumschaltung
Generateur; commutation frequences

Generator, Range Selection
Generador y selector de frequencia



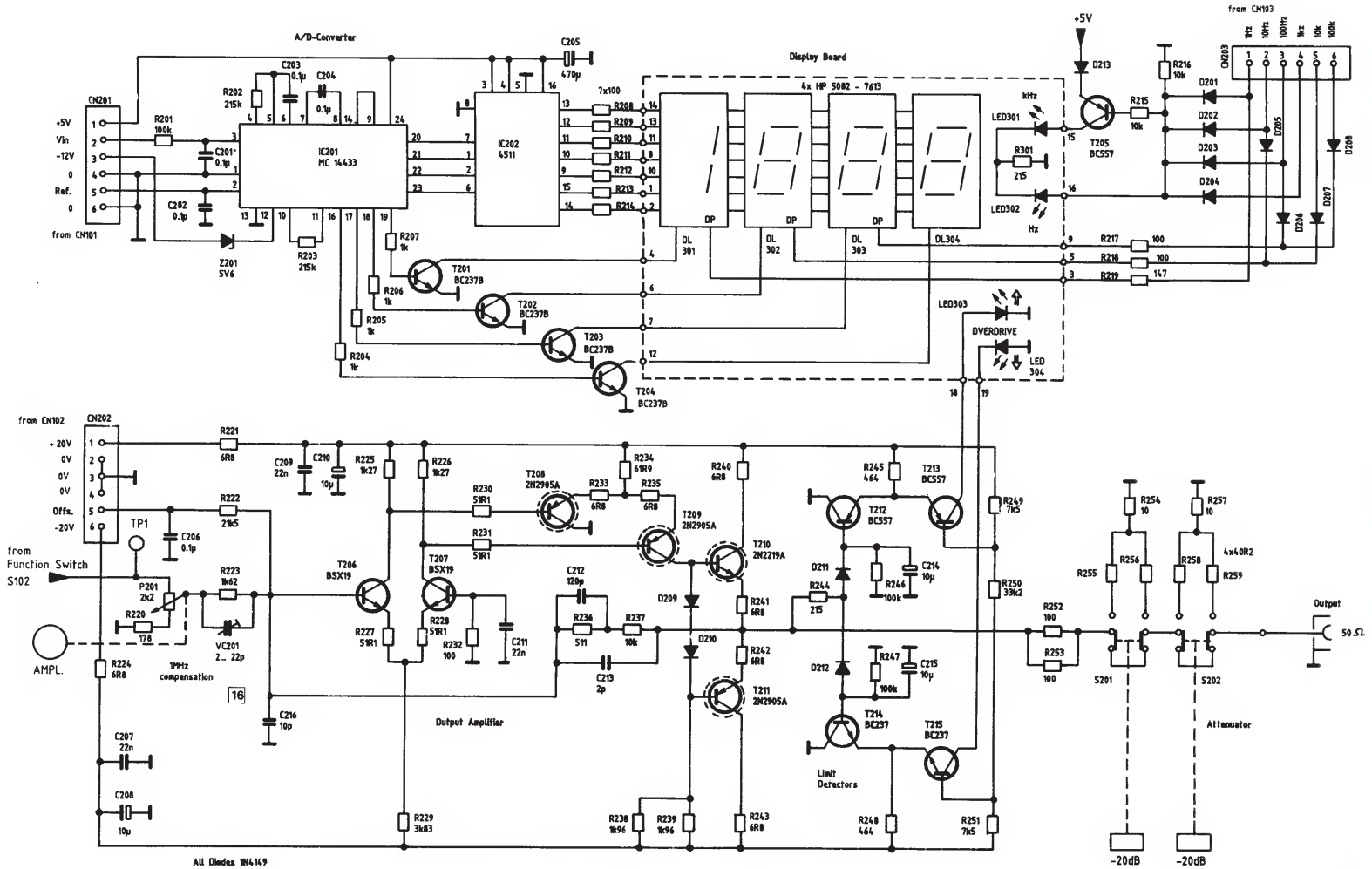
Vorverstärker, Signalformung
Preamplificateur; mise en forme signaux

Buffer Amplifier, Signal Shaping
Amplificador separador y formacion de la señal



Endverstärker, digitale Anzeige
Amplificateur final; affichage numerique

Output Amplifier; Digital Display
Amplificador de salida; Indicador digital



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